METHOD AND SYSTEM FOR TRANSPORTING MAILPIECES IN A PRINTING STATION

Technical Field

The present invention relates generally to a transport system that uses driving belts to move mailpieces and, more particularly, a transport system to move a mailpiece into a printing station to be printed with an indicia, address, advertisement slogan, or other image.

Background of the Invention

Mailing machines utilizing an inkjet printer to print an indicia on a mailpiece are well known. Typically, an inkjet printer uses a print head consisting of one or more rows of nozzles to apply ink droplets over a printed area on the mailpiece surface. Because the printing must be completed over a period of time while the mailpiece moves past the nozzles, the printed image on the mailpiece could be distorted if the mailpiece is not moved in accordance with a specified speed or along a specified direction. Furthermore, the distance between the mailpiece surface to be printed and the nozzles must be appropriately spaced so as to avoid contact by the mailpiece surface with the nozzles.

For imaging, printers typically use rollers to move a substrate into the printing area while also limiting the gap to maintain image quality. These printers do not provide a mechanism to maintain the correct distance between the substrate surface and the print head for a wide range of substrate thickness. While those printers can be used to make print on regular paper stocks or postcards, they are not designed for printing mailpieces the thickness of which can vary considerably. Furthermore, in a printer that uses belt and rollers to ingest the mailpiece, the hard nip formed by the driven belt and rollers could cause the mailpiece to slow down relative to the transport belt when the mailpiece hits the hard nip. Moreover, if the mailpiece is guided by one or more nips formed by the driven belt and rollers, the motion of the mailpiece could be skewed such that the mailpiece may not travel along a specified direction through the printing area of the printer. The skewed motion of the mailpiece may distort a printed image printed by an inkjet printer or the like.

It is advantageous and desirable to provide a transport system to mailpieces in a printer for digital printing, wherein the aforementioned disadvantages can be eliminated.

Summary of the Invention

The first aspect of the present invention is a double-belt transport system having an upstream end and a downstream end for moving a mailpiece from the upstream end into a printing area of a printer, wherein the mailpiece has a lower surface and an opposing upper surface to be printed by a print head located in the printing area. The transport system comprises:

an upper belt looping around an input pulley and an exit pulley to form a straight section covering the printing area and defining a registration plane of the print head;

a lower belt having an intake section running from the upstream end towards the downstream end, wherein the input pulley and the intake section form an ingest nip for providing a friction force to move the mailpiece from the upstream end into the printing area for printing.

Preferably, the double belt transport system further includes a shield plate having a reference surface facing the direction of the inkjet drop trajectory and located substantially in the registration plane in the printing area so as to allow the upper surface of the mailpiece to press against the reference surface of the shield plate for registration.

Preferably, the double belt transport system also includes a lifting mechanism located below the lower surface of the mailpiece for urging the mailpiece to register against the shield plate so that the upper surface of the mailpiece is kept in contact with the straight section while the mailpiece moves through the printing area.

Preferably, the double belt transport system also comprises a deck having an upstream section and a downstream section, wherein the upstream section is located adjacent to the ingest nip for supporting the mailpiece when the mailpiece moves towards the ingest nip.

Preferably, the double belt transport system further comprises a driving mechanism to drive both the upper looping belt and the lower looping belt in order to reduce shearing on the mailpiece.

Preferably, the double belt transport system also comprises a velocity measurement mechanism, such as an optical encoder, operatively connected to at least one of the looping belts to ensure that the printing speed of the print head is consistent with the moving speed of the mailpiece in the printing area.

The second aspect of the present invention is a method of moving a mailpiece from a downstream end towards an upstream end into a printing area having a length, wherein the mailpiece has a lower surface and an opposing upper surface to be printed by a print head in the

printing area. The method comprises the steps of:

providing an upper belt having a straight section located between an input pulley and an exit pulley running the length of the printing area for defining a registration plane of the print head; and

providing a lower belt having an intake section running from the upstream end towards the downstream end, wherein the intake section and the input pulley form an ingest nip to provide a friction force to move the mailpiece into the printing area for printing.

Preferably, the method also comprises the step of urging the mailpiece to move towards the upper belt so that the mailpiece surface is kept in contact with the straight section of the upper belt.

Preferably, the method further comprises the step of providing a shield plate having a reference surface facing the direction of the inkjet drop trajectory and located substantially on the registration plane in the printing area so as to allow the upper surface of the mailpiece to press against the reference surface of the shield plate for registration.

The third aspect of the present invention is a printer having an upstream end and a downstream end for printing on the upper surface of a mailpiece. The printer comprises a print head located above a printing area; and a double belt transport system for moving the mailpiece from the upstream end into the printing area, wherein the mailpiece has a lower surface opposing the upper surface, and wherein the double belt transport system comprises an upper looping belt having a straight section covering the printing area, wherein the straight section defines a registration plane regarding the print head; and a lower looping belt having a mailpiece intake section running from the upstream end towards the downstream end, wherein the mailpiece intake section and the straight section form an ingest nip for providing a friction force to move the mailpiece into the printing area for printing.

The present invention will become apparent upon reading the description taken in conjunction with Figures 1 to 5d.

Brief Description of the Drawings

Figure 1 is a diagrammatic representation illustrating the double belt transport system, according to the present invention.

Figure 2 is a diagrammatic representation illustrating the side view of the transport

system.

Figure 3 is a diagrammatic representation illustrating the driving mechanism and the registration mechanism.

Figure 4 is an isometric view illustrating the pulley, rollers, and the velocity encoder mechanism.

Figure 5a is a diagrammatic representation illustrating a front cross sectional view of the preferred embodiment of the present invention.

Figure 5b is a diagrammatic representation illustrating another embodiment of the present invention.

Figure 5c is a diagrammatic representation illustrating yet another embodiment of the present invention.

Figure 5d is a diagrammatic representation illustrating a further embodiment of the present invention.

Detailed Description

Figure 1 illustrates the double belt transport system **10** of the present invention. Preferably, the transport system **10** is used to move a mailpiece **1** in a digital printer which uses a print head **102**, such as an inkjet print head or the like, to print text, graphics or an image on the mailpiece **1**. As shown, the transport system **10** comprises an upper belt **12** and a lower belt **14** for transporting the mailpiece **1** from the upstream end along an input direction **202** to the downstream end along an exit direction **212**. A deck **16** is used to support the mailpiece as the mailpiece enters and exits the transport system **10**. A lifting mechanism **70** located below the print head **102** is used to urge the mailpiece **1** to move upwards toward the print head **102**, while a shield plate **80**, the lower surface of which defines a registration plane **110** (Figure 3), allows the upper surface of the mailpiece **1** to press against the lower surface of the shield plate **80** for registering the mailpiece **1** relative to the print head **102**. The registration plane **110** is separated from the print head **102** substantially by a fixed distance. For example, if the print head **102** includes one or more rows of inkjet nozzles to provide a plurality of ink droplets for printing, then the distance should be kept minimal to attain the best possible spatial resolution of the print head. However, the distance should also be kept far enough from the print head to avoid smearing of the ink droplets. This distance is seen as a gap between the print head **102** and the

lower surface of the shield plate **80**. This lower surface substantially coincides with the interface between the upper belt **12** and the lower belt **14**, when the mailpiece **1** is not present at the interface, as shown in Figure 2.

As shown in Figure 2, the mailpiece **1** has an upper surface **4** to be printed by the print head **102** and an opposing lower surface **6** supported by the deck **16**. The upper belt **12** loops around idler pulleys **22**, **26**, **28** and a drive pulley **30**. The tension of the upper belt **12** is maintained by a tensioning idler **32**. The lower belt **14** loops around idler pulleys **42**, **44** and a drive pulley **50**. The tension of the lower belt **14** is maintained by a tensioning idler **46**. The upper belt **12** and the lower belt **14** form an ingest nip **40** to move the mailpiece **1** into the printing area **112** for printing. The upper belt **12** has a straight section **24** between the pulleys **26** and **28** running the length of the printing area **112** for holding the mailpiece **1** on both the upper surface **4** and the lower surface **6** in order to minimize skew of the mailpiece **1** as the mailpiece **1** moves through the printing area **112**. The ingest nip **40** is in fact a soft nip, which is formed gradually by the wedge-shaped gap between the upper belt **12** and the lower belt **14** at the upstream end. The ingest nip **40** prevents the mailpiece **1** from slowing down as it would if the ingest nip were a hard nip. The plane joining the tangent of pulley **26** and the tangent of pulley **28** is substantially parallel to the print plane or the registration plane **110** (Figure 3). Both the upper belt **12** and the lower belt **14** are driven by drive pulleys **30** and **50**, respectively, in order to minimize shearing on the mailpiece **1**. The motor **60** and the driving belt **62** that drive the drive pulleys **30** and **50** are illustrated in Figure 3.

When the mailpiece **1** is ingested into the printing area **112** by the ingest nip **40**, it has the tendency to bend downward. For a thin mailpiece, the straight section **24** of the upper belt **12** and the same section of the lower belt **14** can pinch the mailpiece tightly to keep it from moving away from print head **102** and the registration plane **110**. However, if the mailpiece is thick, puffy or flexible, the straight section **24** of the upper belt **12** and the lower belt **14** may not be able to keep the upper surface **4** of the mailpiece **1** from moving downward and away from the registration plane **110**. Thus, it is preferable to have a lifting mechanism **70** located below the registration plane **110** and underneath the printing area **112**, as shown in Figure 3, to push the mailpiece **1** towards the print head **102**. Furthermore, a shield plate **80** having a lower surface **82** located substantially on the registration plane **110** is used to register the upper surface **4** of the mailpiece **1** precisely with respect to the print head **102**. It is preferred that the lifting mechanism **70** has

an opening (not shown) right under the print head **102** so that the print head **102** will not accidentally print on the lifting mechanism **70** when the mailpiece **1** is not present in the printing area **112**. As shown in Figure 3, a tensioning idler **52** can be used to form an input nip **56** with the input pulley **42** of the lower belt **14** in order to reduce skew when the mailpiece **1** is moved to the belts **12, 14** from the upstream end. The tensioning idler **52** may slow down the mailpiece **1** slightly when the mailpiece **1** hits the input nip **56**. However, when the mailpiece **1** is engaged with the upper belt **12** and the lower belt **14**, it moves along with the belts **12**, **14**. Furthermore, in order to ensure that the printing is in synchronism with the mailpiece **1** in that the drop ejection frequency of the print head **102** is matched to the movement of the mailpiece **1**, it is possible to install an encoder **90** to be operatively engaged with the belts **12**, **14** to measure their moving speed.

As shown in Figure 4, the encoder **90** is connected to an encoder wheel **92**, which is positioned between pulley **26** and pulley **28** of the upper belt **12** such that the encoder wheel **92** is rotated by the motion of the straight section **24** of the lower belt **12** (Figure 2). The belts **12**, **14** are not shown in Figure 4.

In summary, double belts minimize skew of the mailpiece because both the upper and lower surfaces of the mailpiece are held by the belts when it moves through the printing area. Accurate registration of the upper surface of the mailpiece is achieved by the straight section of the upper belt, the shield plate and the lifting mechanism. The lifting mechanism can be loaded upward with springs. A velocity measurement mechanism, such as an optical encoder, is used to measure the speed of the upper belt and, therefore, the speed of the mailpiece in the printing area. The measured speed can be used to coordinate with the activation of the inkjet nozzles of the print head. It is also possible to install one or more encoders to make contact with the mailpiece itself in order to measure the moving speed of the mailpiece.

The printer as described in conjunction with Figures 1 to 4 is oriented in such a way that the registration plane **110** is substantially located on a horizontal plane. However, it should be understood by those skilled in the art that the registration plane can be located on an oblique plane or a vertical plane. Furthermore, the various pulleys in the double-belt transport system, according to present invention, can be substituted by rollers or other cylindrical elements capable of supporting the belts.

Furthermore, the width and the location of the lower belt **14**, in relation to the upper belt

12, can be changed based on the width of the mailpiece **1** (Figure 1). It is preferable to have the inner edge of the lower belt **14** be positioned as close to the print area **112** under the print head **102** as possible, as shown in Figure 5a. This position can help bias a narrow mailpiece against the shield plate **80**. As shown in Figure 5a, the lower belt **14** is slight wider than the upper belt **12**. However, the lower belt **14** can be narrower than the upper belt **12**, or both the lower belt **14** and the upper belt **12** are of the same width, as shown in Figure 5b. Moreover, it is possible to extend the inner edge of the lower belt **14** to the other side of the print head **102**, as shown in Figure 5c. Alternatively, in addition to the lower belt **14**, a second lower belt **14'** can be used to advance the mail. However, the second lower belt **14'** must be driven in synchronism with the lower belt **14** so as not to cause skew and lateral shift in the mail.

Thus, although the invention has been described with respect to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and various other changes, omissions and deviations in the form and detail thereof may be made without departing from the spirit and scope of this invention.